IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Motohiro Itadani, et al.

Serial Number: 10/579,738 Group Art Unit: 2871

Filed: May 18, 2006 Examiner: CALEY, MICHAEL H

For: LIQUID CRYSTAL DISPLAY DEVICE

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
Washington, D. C. 20231

Sir:

The undersigned, Kenichi Harai, declares as follows:

I am a National of Japan, residing at Yokohama-shi, Japan. I am a Staff Chemist of Precision Optics Lab., Research and Development Center, ZEON CORPORATION which is located at 1-2-1, Yako, Kawasaki-shi, Kanagawa-ken, Japan.

I received a master's degree at Osaka City University in 2002. In 2005, I joined ZEON CORPORATION and worked on developing optical apparatus.

I conducted the following supplemental experiment by computer simulation:

1. Object of the Experiment:

The object of the experiment is to obtain by computer simulation omni-directional contrast ratios near the critical ranges of the optical parameters, R_e and R_{th}, defined in claim 1 of the liquid display device having an arrangement of optical elements of the first embodiment as illustrated in Fig. 3 of the present specification of US Serial Application No. 10/579,736 which is similar in the structure with the in-plane switching type liquid crystal display in Example 6 of US Pat. No. 6,115,095 (Suzuki et al., referred to as Suzuki herein under) which is cited in the outstanding Office Action mailed on May 20, 2009 and compare the

obtained values of omni-directional contrast ratios with those obtained for the crystal display in the Example 6 of Suzuki under the same simulating condition.

2. Optical calculation

(1) System for simulation

Suzuki discloses that they carried out simulation (e.g., column 13, lines 60 to 61 of Suzuki) but do not disclose concretely the apparatus for carrying out the simulation and conditions for the simulation. Accordingly, LCD Master which is a calculation software soled by SHINTECH, Inc. was used. Method of calculation of LCD Master is based on 4×4 matrix method. The 4×4 matrix method is valuable for analyzing propagation of light through media such as liquid crystals or retardation films which exhibit optically anisotropic properties.

Conditions for calculation for various optical elements will be set forth in the following.

(2) Conditions of Experiment

i) Liquid crystal cell device

The birefringence value Δn (=Re/d, which is defined as index anisotropy in Suzuki, wherein Re represents an in-plane retardation and d represents a thickness of the liquid crystal cell) was set as 0.067 as same as the value disclosed in Example 6 of Suzuki and d was set as 4.5 μm. As a natural result, the in-plane retardation, Re was 302 nm which was equal to the value as disclosed in Suzuki. The Same liquid crystal cell was used also in Comparative Examples in this Supplemental Experiment.

ii) Polarizer

Characteristic value of polarizer in G1029DU in a database of LCD Master was used.

iii) Optical anisotropic member (optical compensator in Suzuki)

The refractive index of the optical anisotropic member in the direction of the fast axis in Examples 2 to 4 of the present invention was set as 1.585 and the thickness was set as 20 μm.

The optical compensator in Suzuki was set as 1.51207 in the direction of thickness, 1.51140 in the direction of slow axis and 1.51073 in the direction of fast axis, respectively, and the thickness was set as 100 μm as disclosed in column, lines 51 to 52 of Suzuki.

3. Result

Fig. 5 shows a diagram exhibiting an arrangement of the liquid crystal display device used in Examples 2 to 4 of this Supplemental Experiment in which the values of in-plane retardation Re and a retardation in the direction of the thickness Rth of the optically anisotropic member is set near the critical values as defined in the formulae in claim 1. In the figure, reference numbers 1 (-15 deg) and 4 (75 deg) each represents a polarizing plate, 2 (75 deg) represents a liquid crystal cell, 3 (-15 deg) represents an optical anisotropic member, respectively. The arrows in the figure show the direction of the absorption axis in the polarizing plate, the direction of the slow axis in the optical anisotropic member and the direction of the initial orientation of liquid crystal molecules in the liquid crystal cell (or the direction of in-plane slow axis of the liquid crystal of the liquid crystal cell under application of no voltage defined in the present invention), respectively. The figures in the parentheses each represents the azimuth angles of the direction of the absorption axis of the polarizing plate, the direction of the slow axis of the anisotropic member and the direction of the initial orientation of the liquid crystal molecule, respectively, each being measured from the direction in which the electric field exists (φ=0) as specified in column 14, lines 6 to 7 of Suzuki. Since Suzuki discloses that the initial orientation azimuth φLC0 of the liquid crystal layer 20 is 75 degrees, the direction of the initial orientation of liquid crystal molecules in the liquid crystal in Examples 2 to 4 was set as 75 degrees in consistent with that of the liquid crystal display in Example 6 of Suzuki. The direction of the absorption axis of the polarizing plate, the direction of the slow axis of the optical anisotropic member in Examples 2 to 4 were configured as defined in the arrangement of optical elements of the first embodiment as illustrated in Fig. 3 of the present specification of US Serial Application No. 10/579,736 relative to the direction of the initial orientation of the liquid crystal molecule as set forth above.

Fig. 6 shows a diagram exhibiting an arrangement of the liquid crystal display device used in Comparative Examples 2 and 3 of the present Supplemental Experiment. The reference numbers 5 (-15 deg) and 8 (75 deg) each represents a polarizing plate, 6 (75 deg) represents a liquid crystal layer, and 7 (-15 deg) represents an optical compensator, respectively. Comparative Example 2 corresponds to the liquid crystal display disclosed in Example 6 of Suzuki and Comparative Examples 3 is the same as Comparative Examples 2 except that no optical compensator 7 is used.

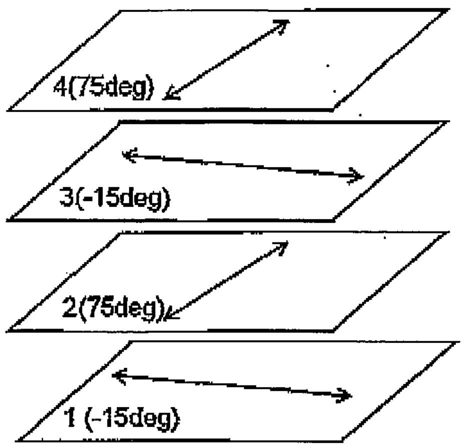

Fig5

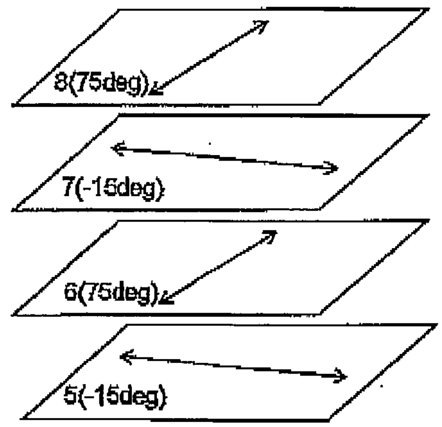

Fig6

The omni-directional contrast ratios were calculated by simulation for the optical displays of Examples 2 to 4 (Fig. 5) and Comparative Examples 2 to 3 (Fig. 6) and the results were summarized in Table 1.

Table 1

* Example	R_e	R_{th}	Omni-directional Contrast Ratio
Example 2	160	-181	15 or larger
Example 3	339	-350	14 or larger
Example 4	174	-150	14.4 or larger
Comparative Example 2	67	-100.5	8.4 or larger
Comparative Example 3	No compensation layer present		9.3 or larger

* Examples 2 to 4 show the data for the liquid crystal display device having the feature of the presently claimed invention in which the values of in-plane retardation Re and a retardation in the direction of the thickness Rth of the optically anisotropic member is set near the critical values as defined in the formulae in claim 1 and Comparative Example 2 shows the data for the in-plane switching type liquid crystal display disclosed in Example 6 of Suzuki which is cited in the outstanding Office Action and Comparative Examples 3 is the same as Comparative Examples 2 except that no optical compensator is used.

4. Discussion

As clearly seen from Table 1, the liquid crystal display device having an arrangement of optical elements of the first embodiment as illustrated in Fig. 3 of the present specification of US Serial Application No. 10/579,736 had a omni-directional contrast ratio of 14 or larger even when the optical parameters

are near the end-points of the ranges of the optical parameters, Re and Rth, defined in claim 1.

In contrast, the in-plane switching type liquid crystal display in Example 6 of Suzuki which is cited in the outstanding Office Action mailed on May 20, 2009 had a omni-directional contrast ratio of 8.4 or larger which is far inferior than the omni-directional contrast ratio of the inventive Examples 2-4.

It is further realized that the in-plane switching type liquid crystal display in Example 6 of Suzuki had an omni-directional contrast ratio even inferior than a crystal display in which an optical compensator was not present.

5. Conclusion

As discussed above, it was confirmed that the liquid crystal display apparatus of presently claimed invention shown below had an advantage over that of the liquid crystal display disclosed in Example 6 of Suzuki with respect to the omni-directional contrast ratio.

One skilled in the art would expect that modifying the optical compensator of Example 6 of Suzuki, to satisfy the following formulae: $160 \leqq R_e \leqq 340$ and $-350 \leqq R_{th} \leqq -150$, would not result in an increase in the omni-directional contrast ratio based on reading Suzuki and other references cited, since Suzuki and other references cited teach nothing about the formulae and one skilled in the art would not even consider a limitation by such formulae and there is no reason to modify the optical compensator by introducing the limitation set forth above.

The increase in the omni-directional contrast ratio attained in the presently claimed invention exceeds these expectation set forth above.

Claim 1 as presently amended is: A liquid crystal display device of an in-plane switching mode which comprises a pair of polarizers which are a polarizer at an output side and a polarizer at an incident side and disposed at relative positions such that absorption axes of the polarizers are approximately perpendicular to each other and at least an optically anisotropic member and a liquid crystal cell which are disposed between the pair of polarizers, wherein $n_z > n_x > n_y$ when, with respect to the optically anisotropic member, a refractive index in a direction of an in-plane slow axis is represented by n_x, a refractive index in a direction in-plane and perpendicular to the direction of an in-plane slow axis is represented by n_y, and a refractive index in a direction of a thickness is represented by n_z, each measured using light having a wavelength of 550 nm; and the in-plane slow axis of the optically anisotropic member and the absorption axis of a polarizer disposed closer to the optically anisotropic member are disposed at relative positions approximately parallel or approximately perpendicular to each

other, wherein an in-plane retardation R_e (the unit: nm) and a retardation in the direction of the thickness R_{th} (the unit: nm) of the optically anisotropic member satisfy the following formulae:

$160 \leqq R_e \leqq 340$ and $-350 \leqq R_{th} \leqq -150$,

wherein the absorption axis of the polarizer at the output side and the in-plane slow axis of a liquid crystal of the liquid crystal cell under application of no voltage are disposed at relative positions parallel to each other, and the optically anisotropic member is disposed between the liquid crystal cell and the polarizer at the output side, and

wherein the in-plane slow axis of the optically anisotropic member and the in-plane slow axis of a liquid crystal of the liquid crystal cell under application of no voltage are disposed at relative positions approximately perpendicular to each other.

The undersigned believes that the improved properties would be found for the entire scope of the presently claimed invention set forth above.

The undersigned declares that all statements made herein of his knowledge are true and all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that willful false statements may jeopardize the validity at the application or any patent issued thereon.

Signed this 17 th day of September, 2009

Kenichi Harai

Kenichi Harai